Integrated Communication Navigation and Surveillance (ICNS) Conference

Airport and Terminal Area Communications Architectures

28 April 2004

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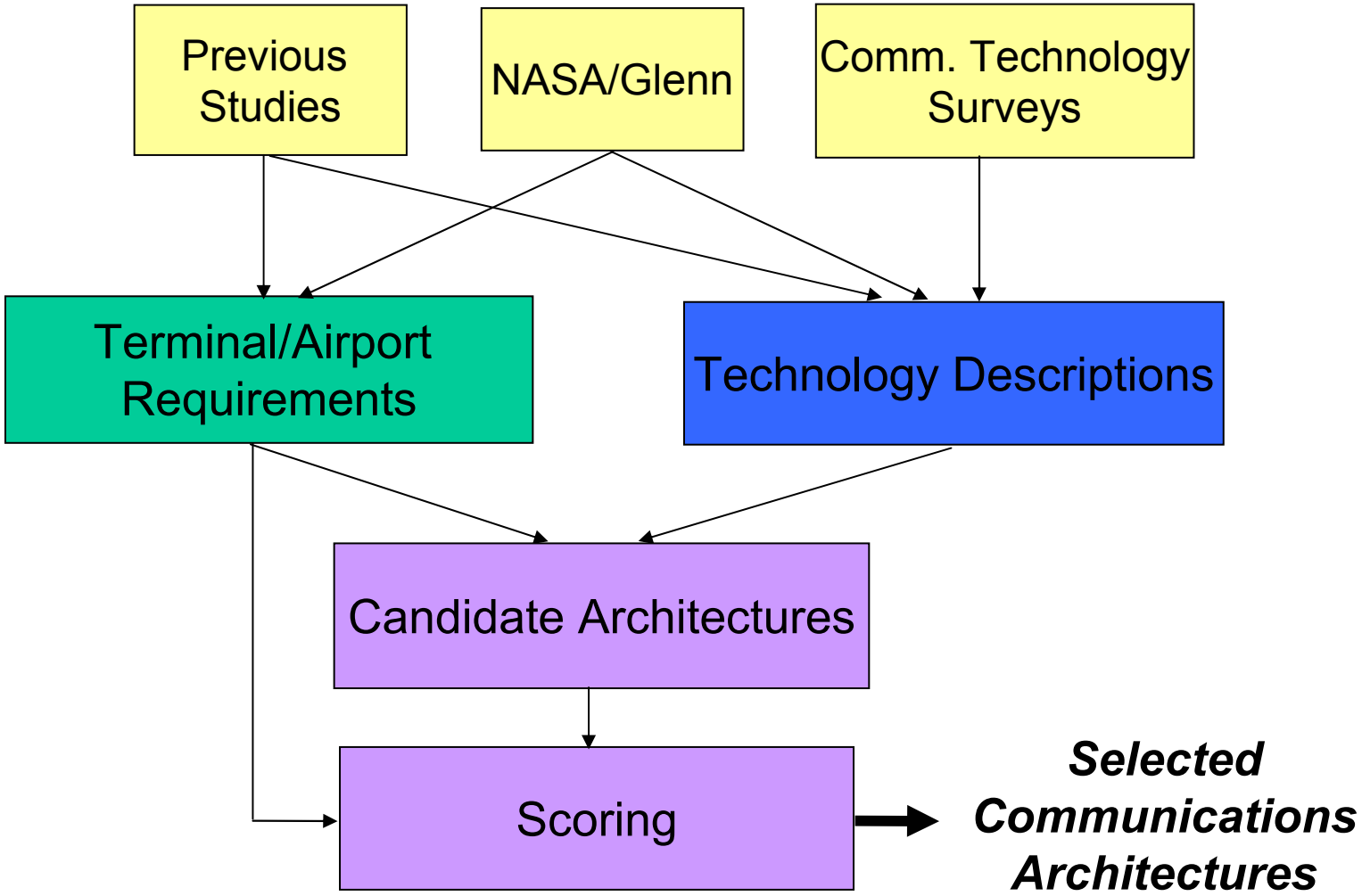
Outline

- Project Background
- Architecture Analysis Process
- Airport Surface and Terminal Area Requirements
- Architecture Analysis
- Summary

Project Background

- APL is sponsored by the NASA Glenn Research Center (GRC) in the Weather Information Communications (WINCOMM) element of the Aviation Safety Program (AvSP)
  - Communications architecture development
  - Modeling/simulation (M&S)
- Architecture work is focused on two aviation applications:
  - Flight Information Services (FIS)
  - Tropospheric Airborne Meteorological Data Reporting (TAMDAR)
- M&S work focused on Automated Dependent Surveillance -Broadcast (ADS-B) links

Architecture Analysis Process



Definitions

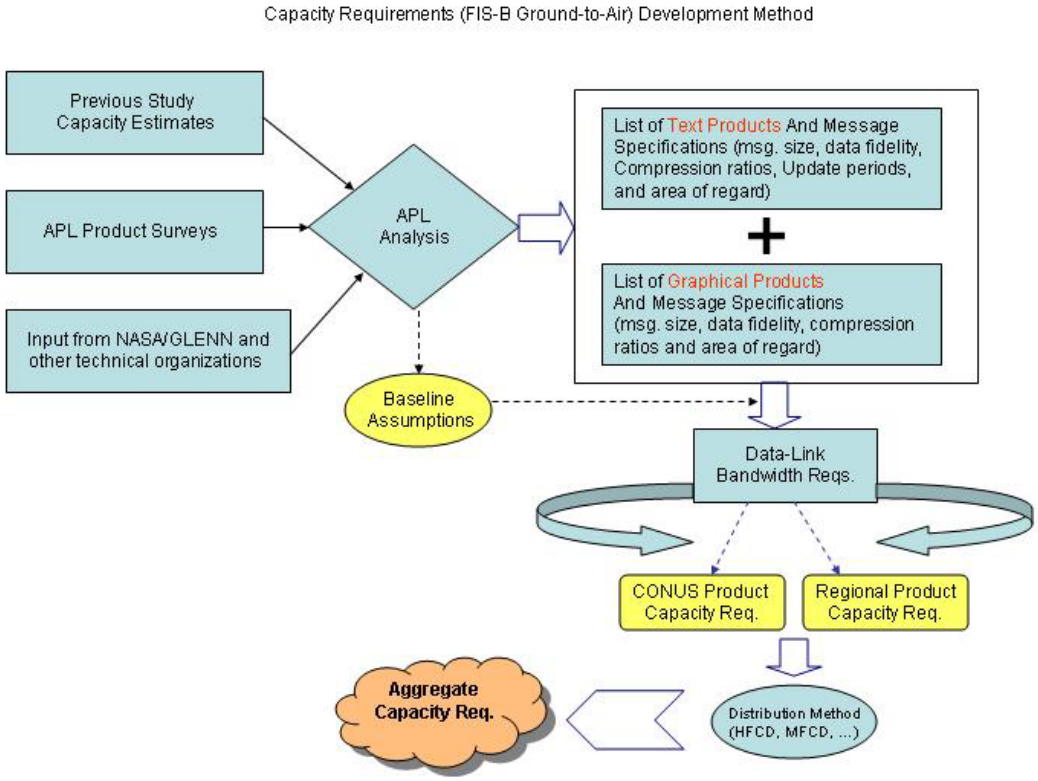
- Definitions required for regions of interest
  - No standard exists
  - Working definitions resulted from NASA GRC and APL discussions
  - Partitioned study to terminal area and airport
- Terminal
  - Arrival and departure region under 10,000 ft
  - Radius of 100 miles from airport
- Airport
  - Surface and within 5 miles from airport
- View weather and NAS status distribution in these domains as a subset of FIS-B system

Requirements

- Requirements were examined across the following areas:
  - Latency
  - Capacity
  - Connectivity/Topology
  - Number of Elements
  - Platform Constraints
  - Coverage
  - Link Availability
  - Cost
  - Traffic Type
  - Protection
  - Spectrum
- Various sources were used to derive estimates

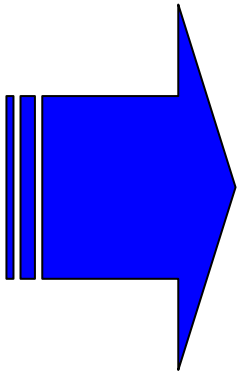
Capacity Analysis

- As with FIS-B en route study, capacity was most difficult requirement to determine
- Capacity is a function of required product types, sizes and latency
  - Primarily weather products
  - "NAS Status" also included as part of FIS (e.g., NOTAMs)
- APL determined a "first principles" estimate
- Capacity aggregate still involves multiple distribution approaches
  - High Fidelity Comprehensive Distribution (HFCD)
  - Multiple Fidelity Comprehensive Distribution (MFCD)



Airport Region

- Adopted a conservative approach to product inclusion
- Products
  - Surface Observation (METAR/SPECI- coded)
  - Terminal Area Forecast (Text- coded)
  - D-ATIS (Digital Text)
  - RVR (Runway Visual Report)
  - Convective SIGMET
  - Domestic SIGMET
  - AIRMET (Text)
  - Severe Weather Forecast Alert (Text)
  - Severe Weather Forecast Alert (Graphic)
  - Icing
  - Current Icing Potential (CIP)
  - Forecast Icing Potential (FIP)
  - National Convective Weather Forecast (NCWF) national
  - National Convective Weather Forecast (NCWF) national
  - Collaborative Convective Forecast Product
  - NEXRAD (National Composite Graphical)
  - NEXRAD (Graphical Regional)
  - NEXRAD (Graphical Regional 2km)
  - TWIP
  - Lightning (national depiction)
  - NOAA Radar Summary Chart
  - Area Forecast (text)
  - Pilot Report (PIREP) (Text)
  - Winds and Temps. Aloft
  - Significant Weather Prognostic Chart (low/high altitude)
  - Notices to Airmen
  - 3D Turbulence Diagnostic & Forecasting Product



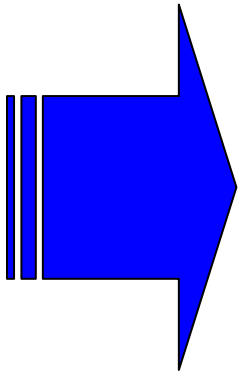
MFCD Capacity: 451.8 kbps
HFCD Capacity: 872.2 kbps

Airport Requirements Rollup

Scoring Requirement Area	Airport Surface FIS-B Requirements
Ground-to-Air Capacity	High-Fidelity, Comprehensive: 872.2 kbps Multi-Fidelity, Comprehensive: 451.8 kbps
Platform Constraints	Appropriate for GA/regional aircraft
Coverage	5 mile airport radius
Cost	Under $5000 NRE; minimum recurring
Spectrum/Deployment	System operational by 2007 and 2015
Link Availability	99%
Latency	5 minutes

Terminal Region

- Products
  - Surface Observation (METAR/SPECI-coded)
  - Terminal Area Forecast (Text-coded)
  - D-ATIS (Digital Text)
  - RVR (Runway Visual Report)
  - NEXRAD (Graphical Regional)
  - TWIP
  - Lightning



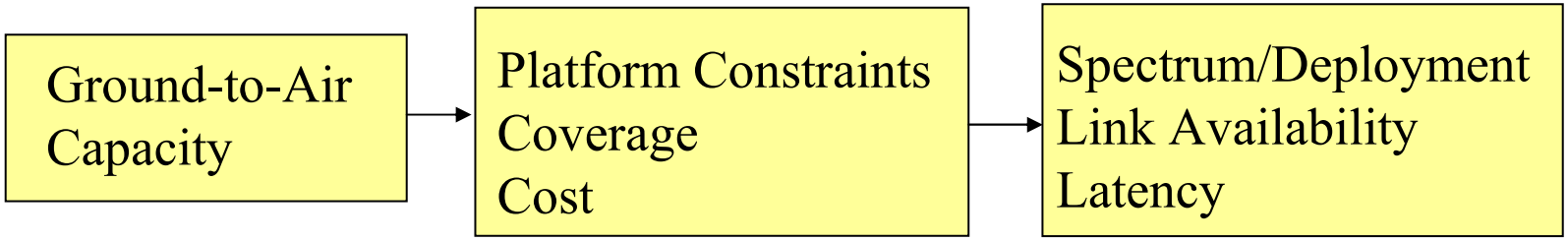
MFCD Capacity: 9.7 kbps

Terminal Requirements Rollup

Scoring Requirement Area	Terminal FIS-B Requirements
Ground-to-Air Capacity	Multi-Fidelity, Comprehensive: 9.7 kbps
Platform Constraints	Appropriate for GA/regional aircraft
Coverage	100 mile airport radius
Cost	Under $5000 NRE; minimum recurring
Spectrum/Deployment	System operational by 2007 and 2015
Link Availability	99%
Latency	1 minute

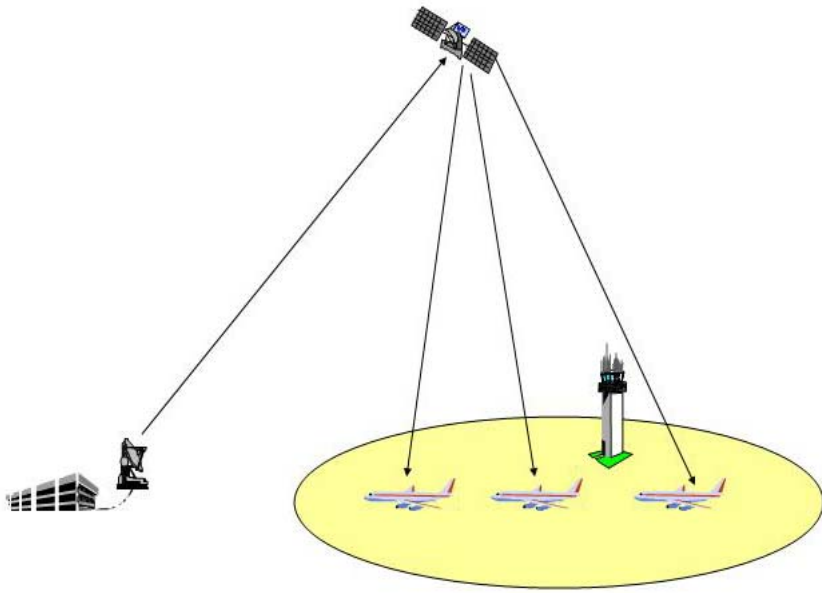
Scoring Methodology

- Scoring conducted through a series of "filters"
- Only viable technologies passed to next scoring filter

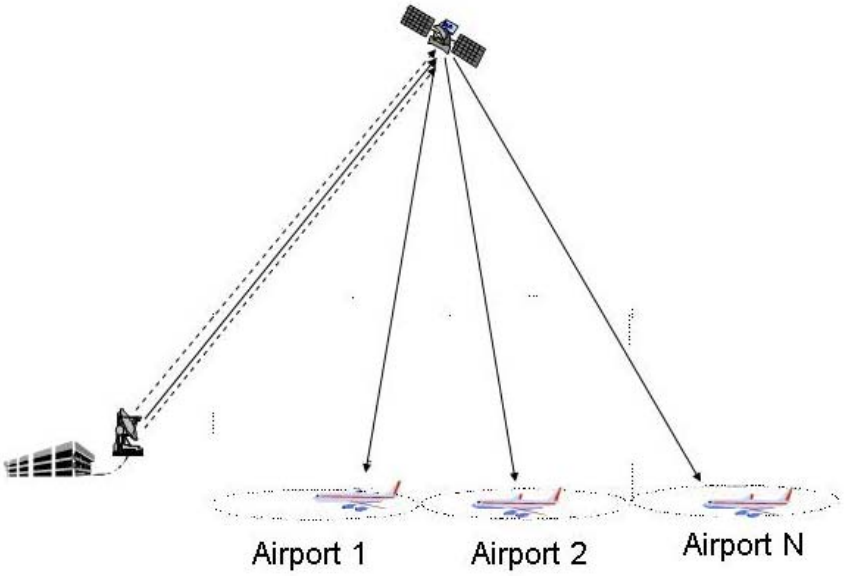


Score	Description
-1	System does not meet requirements
0	Information obtained is currently inadequate to score
1	System can support requirement
2	System can support requirement with substantial margin

SATCOM Architectures



HFCD



MFCD

SATCOM Scores

Airport

System	HFCD	MFCD
Iridium	-1	-1
Globalstar	-1	-1
ICO	2	2
Ellipso	-1	-1
Teledesic	2	2
Inmarsat	-1	1
Spaceway	2	2
eSAT	-1	1
UHF	-1	-1
SHF	2	2
S-DARS	0	0
Store-and-Forward	-1	-1

System	Platform Constraints	Coverage	Cost
ICO	1	2	1
Teledesic	-1	2	-1
Inmarsat	2	2	1
Spaceway	-1	2	-1
eSAT	0	2	0

System	Spectrum/ Deployment	Link Availability	Latency
ICO	1	0	2
Inmarsat	2	0	2

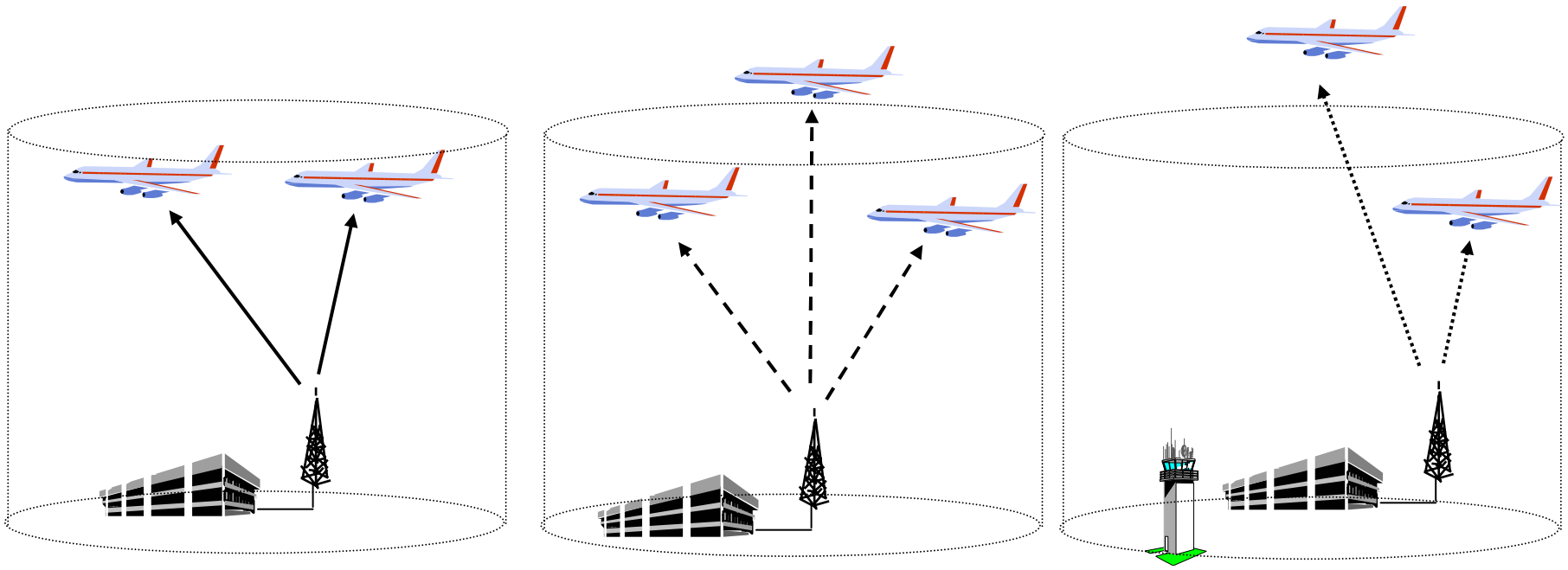
Terminal

System	MFCD
Iridium	1
Globalstar	1
ICO	2
Ellipso	2
Teledesic	2
Inmarsat	2
Spaceway	2
eSAT	2
UHF	2
SHF	2
S-DARS	0
Store-and-Forward	-1

System	Platform Constraints	Coverage	Cost
Iridium	2	2	2
Globalstar	2	2	2
ICO	1	2	1
Ellipso	1	2	1
Teledesic	-1	2	-1
Inmarsat	2	2	1
Spaceway	-1	2	-1
eSAT	0	2	0

System	Spectrum/ Deployment	Link Availability	Latency
Iridium	1	0	2
Globalstar	1	0	2
ICO	1	0	2
Ellipso	1	0	2
Inmarsat	2	0	2

LOS Architectures



LOS Scores

Airport

System	HFCD	MFCD
VDL M2	-1	-1
VDL M3	-1	-1
VDL M4	-1	-1
1090 ES	-1	-1
Mode S	-1	-1
UAT	-1	-1
GATElink	2	2
HFDL	-1	-1
Wi-Fi	2	2
3G Cellular	-1	-1
4G Cellular	2	2
Aircell	-1	-1
Magnastar	-1	-1
Mobitex	-1	-1
ACARS	-1	-1
AAN	-1	-1

System	Platform Constraints	Coverage	Cost
GATElink	2	-1	0
Wi-Fi	2	-1	2
4G Cellular	2	1	2

System	Spectrum/ Deployment	Link Availability	Latency
4G Cellular	1	0	0

Terminal

System	MFCD
VDL M2	2
VDL M3	2
VDL M4	2
1090 ES	2
Mode S	2
UAT	2
GATElink	2
HFDL	-1
Wi-Fi	2
3G Cellular	2
4G Cellular	2
Aircell	1
Magnastar	1
Mobitex	-1
ACARS	-1
AAN	-1

System	Platform Constraints	Coverage	Cost
VDL M2	2	2	1
VDL M3	2	2	1
VDL M4	2	2	1
1090 ES	2	2	1
Mode S	2	2	1
UAT	2	2	1
GATElink	2	-1	0
Wi-Fi	2	-1	2
3G Cellular	2	1	2
4G Cellular	2	1	0
Aircell	2	1	1
Magnastar	2	1	-1

System	Spectrum/ Deployment	Link Availability	Latency
VDL M2	2	2	2
VDL M3	1	2	2
VDL M4	1	2	2
1090 ES	2	2	2
Mode S	2	2	2
UAT	2	2	2
3G Cellular	1	0	2
4G Cellular	1	0	2
Aircell	2	0	2

Summary

- Capacity varies greatly depending on product composition
  - Dominated by a few large products
- Terminal has many options however the role of terminal vs. en route FIS and airport domain should be assessed
- Airport region has significant capacity due to the conservative inclusion of products
  - Results in few technology options
  - Range is important requirement to refine
  - Commercial wireless may be a suitable technology for shorter ranges